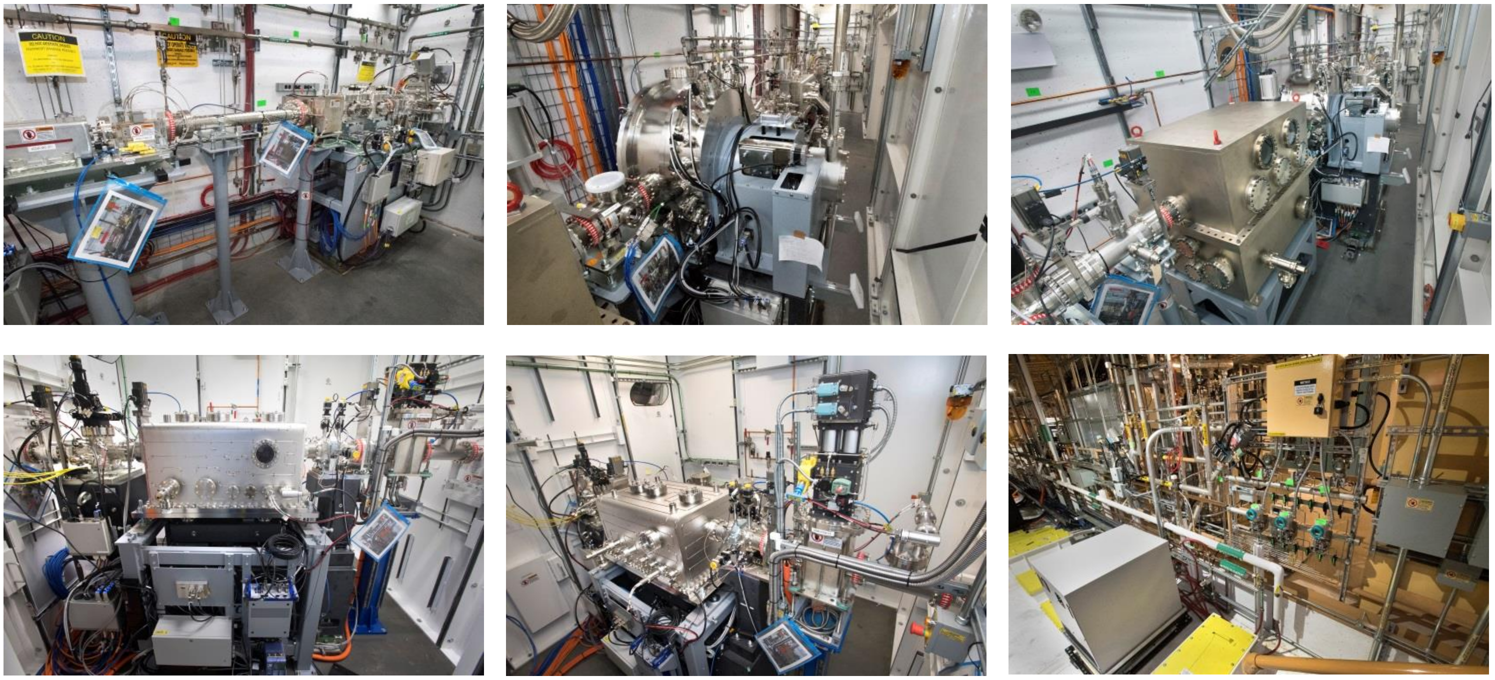
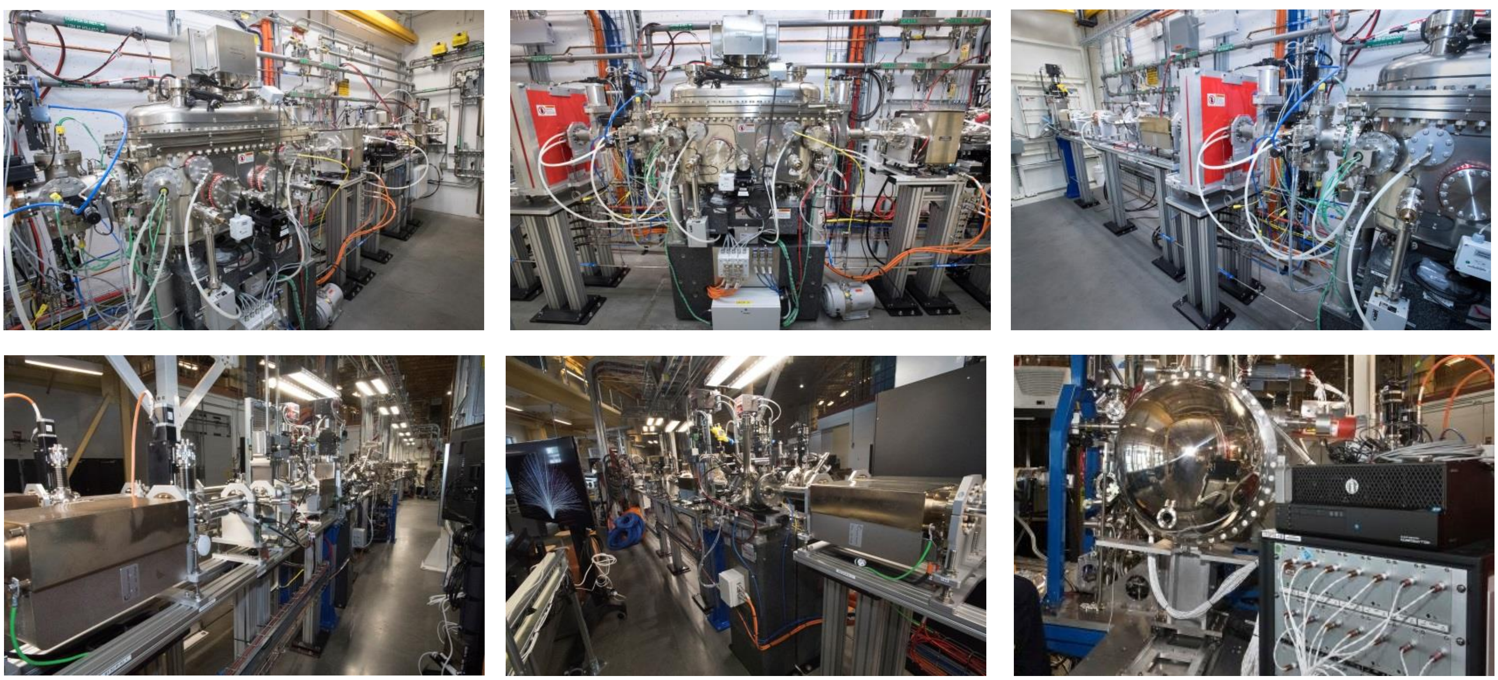
NSLS-II Experimental Tools (NEXT)

May 2016 Project Activity

Report due date: June 20, 2016



ISR beamline views, mostly of PDS, shown following IRR



ESM beamline views, mostly of PDS, shown following IRR

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OVERALL ASSESSMENT

Installation progress continued at all NEXT beamlines during May, with focused effort at ISR and ESM in advance of their IRRs, scheduled for June 28-29. Equal attention was devoted to preparation of documentation required for these IRRs, such as radiation shielding analyses, travelers, and the Instrument Readiness Plans.

The ISS focusing toroidal mirrors, covering different photon energy ranges, were installed in May. These mirrors are expected to be commissioned with beam in June, providing a focused beam in the ISS B1 endstation.

Installation progress continues to be made at SMI, for both the PDS and the endstation. With PDS installation substantially complete at the end of May, SMI is proceeding with radiation shielding calculations. SMI is expected to be ready for IRR as soon as PPS and EPS systems are installed and tested.

SIX has completed FDRs for the endstation equipment: the sample chamber, with its unique triple rotating flange, and the 15m-long soft x-ray emission spectrometer. Fabrication and assembly activities are well underway by the principal endstation contractor, Bestec. Final assembly of the SIX PDS will be undertaken by NSLS-II technicians in July, following the late-June ESM IRR.

Two significant procurements were completed in May: ISS focusing mirror and SMI CRL optics. Monitoring and management of contractor progress on the 23 remaining major procurement contracts are important ongoing activities that are crucial to maintaining project schedule. Nine of these contracts are for SIX, 6 are for ISR, 4 are for ISS, 2 for SMI, and 1 each for ESM and Insertion Devices (Scienta Analyzer and ESM EPU105).

As of May 30, 2016, the project is 86.0% complete based on base scope performance earned to date. The cumulative EVMS schedule and cost indices both remain at 0.94.

Two PCRs were approved and implemented during May, one for award of a contract for additional grating substrates for SIX (+$154k) and the other a no-cost amendment of the ISR 6-Circle Diffractometer contract. These PCRs increased BAC by $0.15M, to $82.6M. Cost contingency is $7.4M, which is 63.9% of $11.6M BAC work remaining. The EAC, reported as the sum of actual cost to date (ACWP) plus the estimated cost to complete (ETC), is $87.50M, $0.84M greater than the April value. The increase is broken down as: $0.15M increase in BAC from PCRs, $0.40M cost overage on work performed ($0.14M M&S overage, $0.26M labor overage), $0.24M increase determined via the comprehensive EAC assessment conducted in May (M&S -$8k, labor +$245k), and corrections $0.05M. As of the end of May, contingency on EAC is $2.50M, which represents 21.1% of $11.9M EAC work remaining, or 47.2% of $5.3M unobligated work to go ($6.6M of the remaining work is obligated to fixed-price equipment contracts). ETC will continue to be assessed monthly through project completion to understand and contain costs while maintaining the good schedule performance that the project has demonstrated to date.

Looking ahead, the bottom-up EAC assessment conducted in May will inform the contingency planning process to be conducted in June and July. On a similar schedule, a project risk update will be initiated in June and finalized in July.

COMMON SYSTEMS

Utilities installation is nearing completion. With only finishing electrical work remaining, the electrical utilities installation milestone was achieved late in the month. The small amount of mechanical utilities work performed in May included integration of DI water to beamline components at ISR and ESM, along with continuing support of IRRs at those two beamlines. Remaining utilities installation work in the SIX Satellite Building is expected to start in June and finish once the endstation spectrometer arm is installed. In addition, the design for the SMI exhaust ducting has been finished. Installation will likely be in July.

Significant progress continued to be made in PPS design, installation, and testing this month. Most significantly, the ESM and ISR PPSs were both certified this month, including the reach backs to the linac. The EPS team is continuing to receive EPS requirements for each beamline, and their efforts are being directed to where major beamline component installations are underway or soon will be taking place. EPS installation activities at ESM were completed last month; integration and testing activities are underway. EPS progress in the ISR hutches also continued to make good progress in May, with installation finishing and integration and testing starting. This work will continue into June, as beamline components are installed and put under vacuum. At SMI, the EPS requirements were received this month, and installation is expected to start by the end of June, as resources become available.

The remaining control station furniture at ISR and ESM is on order and expected to be delivered by mid-June. Integration of AC power and network cables for all NEXT control stations is planned to occur over the next few months, once the control station partitions are received and installed. Depending on the timing of the furniture delivery, careful coordination with the ESM and ISR IRRs in late June will be required.

BEAMLINE CONTROLS

Controls engineers were fully occupied supporting supplier installations at all five beamlines during May. Testing activities required for component installations include: checkout of point-to-point functionality of motion controls for each motor axis, refining of motion tuning in near operating conditions (e.g. under mechanical and vacuum loading); developing and adapting motion, PLC programs, and EPICS IOCs for motion controls; and adding standard features such as IOCadmin, autosave, and CSS operator screens. A standard controls checklist has been used as a template to prepare for IRRs.

For the beamlines scheduled to undergo IRR in June, ESM and ISR, cable termination and network installation made good progress during May. All controllers and most of the diagnostic equipment have been connected to the controls network. In addition, control engineers for these two beamlines also continued developing EPICS support for functions such as beamline diagnostics, vacuum IOCs, etc.

For the SMI and ISS beamlines, controls engineers participated in controls aspects of the site acceptance tests for Hexapods from Physik Instrumente.

ESM – ELECTRON SPECTRO-MICROSCOPY

ESM installation activities continued at 21-ID during May, in advance of the IRR scheduled for late June. Installation of PDS components in the FOE has been completed, along with considerable progress on installation of the ARPES endstation.

The layout of the ESM FOE is relatively simple: besides diagnostic units to characterize undulator emission, it contains the first mirror (M1) and the missteered-beam masks. These masks are important components of the radiation protection system: these water-cooled masks receive any missteered white or pink beams and prevent them from impinging on any uncooled surfaces downstream. In the first stage of the beamline, upstream of the monochromator, the ESM undulator beam is intense, carrying a power of about 1 kW.

ESM has two types of water-cooled missteered beam masks, shown in Figure 1: one for white beams and another for pink beams (downstream of M1). These masks were designed in house and fabricated in the BNL workshops. Following the well-established experience of our machinists, all masks have been fabricated from Glidcop®, Cu that is dispersion strengthened with Al_2O_3 particles. Glidcop® is mechanically much harder than Cu, although it retains the high thermal conductivity of Cu and offers improved radiation resistance. Glidcop® is so hard that knife-edges for soft Cu gaskets can be directly machined into flanges made from it, much in the same way as is usually done for stainless steel flanges. This engineering methodology is very convenient because it allows for simple monolithic designs, avoiding the difficulties of brazing Cu with stainless steel.

FEA calculations have been conducted for these masks to analyze the thermal impact of receiving the full beam and therefore to ensure their structural integrity in the worst case thermal scenario. These masks, as part of the ESM PPS system, will be surveyed in place and their water flow and temperature will be monitored constantly. Following fabrication, these masks will be tested and installed in June, in order to have them ready for the ESM IRR on June 28th.

Looking forward, the month of June will be dedicated to completing component installation. Besides the white and pink beam masks, the primary and secondary GBS lead shields will be installed. Assembly of the DiagOn undulator diagnostic will be completed by mounting the custom multilayer optics. In preparation for IRR, all component documentation will be completed and all travelers will be processed and approved.

Figure 1: ESM: ESM white beam mask (top right) and four pink beam masks.

ISR – IN-SITU AND RESONANT HARD X-RAY

Survey data drawings for the FOE granite and vacuum chambers and for the shielded beam transport system were released. Individual vendor item control drawings of the bremsstrahlung collimators, bremsstrahlung stop, and the DHRM were also released. Drawings of the lead sheets for the secondary bremsstrahlung shield were released, and a purchase order for the lead was placed on May 24.

A design review of the secondary bremsstrahlung shield (Figure 2) was held on May 18. There were no action items following the review, but three recommendations for the design of the stand were made: review accessibility to bolts for the beam pipe section upstream of the shield, add gussets on the upstream face of the frame to increase rigidity, and ensure the installation plan identifies the center of gravity and that the frame is securely bolted to the floor when the lead is installed. Stand design refinements have been made, and the drawings are under review.

An update from Toyama on the modified KB Mirrors bender was received on May 25. Toyama proposed an additional modification to the bender (Figure 3), in order to improve motion smoothness and stability. The modified bender and the mirrors will be shipped to BNL in early June, and metrology will be carried out in the NSLS-II Metrology Lab during the week of June 20.

During testing of the ISR PPS device, which was carried out by the NSLS-II Vacuum Group during the first week of May, a ~100 μm diameter pinhole in the capsule was discovered (Figure 4). The device was returned to the supplier; a replacement device is expected to be delivered in June.

Installation of the Gas Handling System by Applied Energy Systems was completed on May 20, and commissioning of the system began.

Toyama personnel completed installation of the FOE Optics Package and the DHRM & SSA on May 13. Specifically, the installation of BPM2, which had been delayed in order to accommodate installation of the Dual Phase Plate Assembly granite and vacuum chamber in late April, was completed; the HFM, VFM, and DHRM mirrors were installed in their vacuum chambers; and all vacuum chambers were pumped down and leak-tested. The DCM crystals were also installed, although an attempt to cool the crystals failed when a level meter in the cryo-cooler malfunctioned. A new level meter is anticipated to be installed in mid-June, when Toyama personnel return to continue commissioning work.

After the May 13 departure of Toyama personnel, installation and commissioning by ISR technicians and members of the NSLS-II Vacuum Group ramped up. With two available bake-out carts, BPM2 was baked, and a bake of the HFM was begun. Bakes of the DPP, VFM, VBD2, BPM3, and DHRM are planned for June. In Hutch C, the terminating gate valve was installed, and vacuum gauges were installed on the ends of the shielded transport pipe sections. In the SOE, the diamond BPM and the mono beam mask, which protects the lead in the second photon shutter from exposure to the beam, were installed, and the mask was surveyed into place.

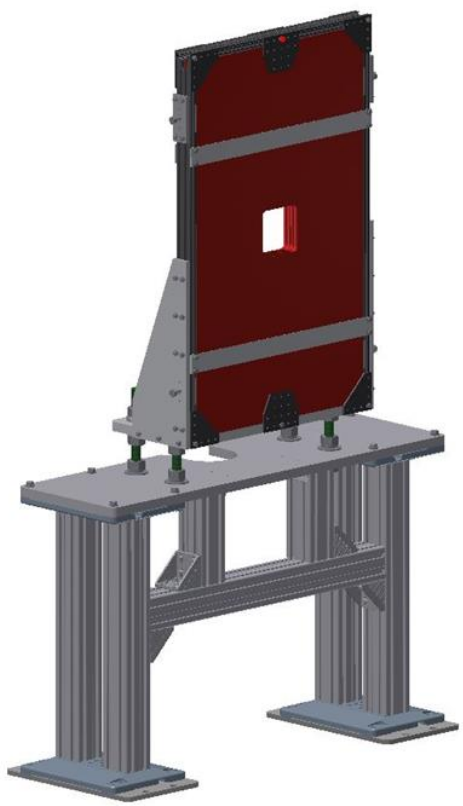


Figure 2: ISR: Model of ISR secondary bremsstrahlung shield.

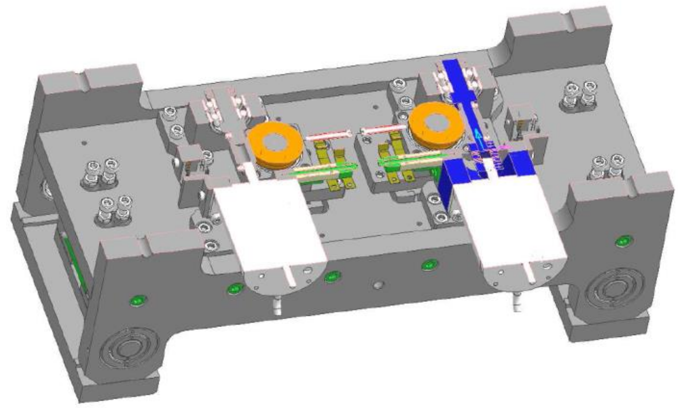


Figure 3: ISR: Model of ISR KB Mirrors' bender from Toyama, with additional parts, shaded in blue, to be added to improve motion smoothness and stability.

Figure 4: ISR: Pinhole in delivered ISR PPS device.

ISS – INNER SHELL SPECTROSCOPY

With the installation of both focusing mirrors, ISS PDS construction is complete. All motors are tested and the EPICS IOC's are installed. The complete system is now ready for commissioning with beam, to be performed in June.

One large endstation procurement, the sample chamber package, was successfully tested during the FAT held May 3-4. This FAT, which included demonstration of the functionality of the support and lens alignment Hexapods and of the controls system, was successfully conducted at PI, the supplier of this system. With 10μrad angular resolution/reproducibility of each of the three rotation axes and a maximal wobble of 50μm, the system exceeds specifications. Its goniometric performance will even enable single crystal diffraction. The system (Figure 5) was delivered to BNL 14 days following the FAT and immediately installed and tested. Two large endstation procurement packages remain to be delivered: the XES Spectrometer Mechanical System and the Sample Handling System.

Installation of the gas exhaust collection system inside the B1 endstation enclosure is nearly completed. Integration of gas and vacuum sensors and valves into the endstation EPS system remains to be completed.

Significant progress was made during May in the development of the ISS control system: development and testing of an analog version of the so-called Pizza box FPGA units was completed. This unit, which consists of electronics that tag an analog signal with the high-resolution global time stamp, represents the last piece of hardware for the ISS data acquisition system. Successful development and testing of the EPICS interface is another success of the controls effort at ISS.

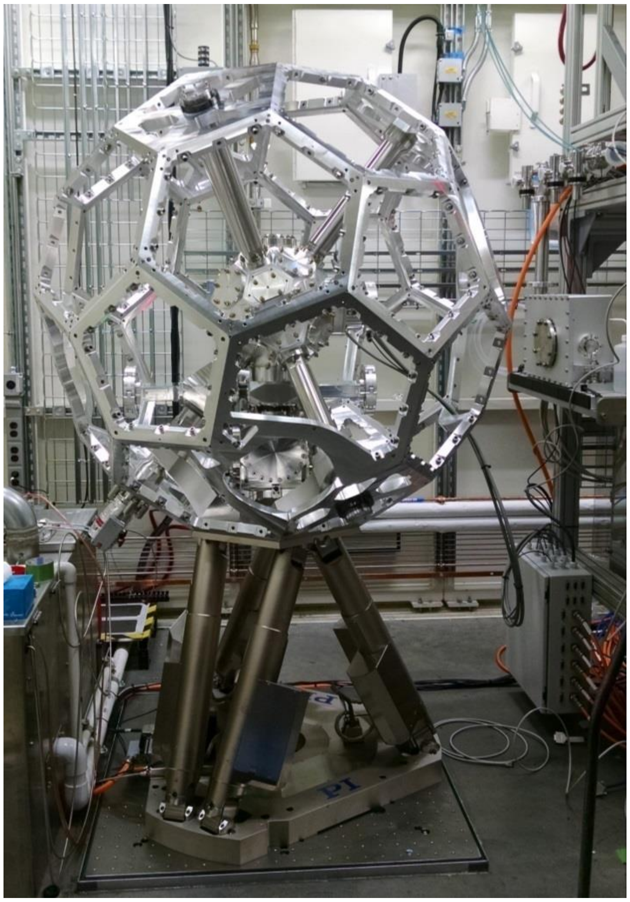


Figure 5: ISS: The ISS sample chamber system, including the mounting cage for emission spectrometers, installed at 8-ID-B1.

SIX – SOFT INELASTIC X-RAY

With the final design of the Bestec endstation components now frozen, the SIX team was able to complete the cable study for the SIX satellite building. This study includes the numerous motor, vacuum, and signal cables for the sample chamber and spectrometer arm, in addition to those for the portion of the photon delivery system downstream of mirror M3. The vacuum controllers are located on the experimental floor, just upstream of the bypass corridor, while the motion controllers are located inside the electronics room of the satellite building. The cable study included a layout of the different cable routes that can be understood and used by all of the involved staff, mechanical engineers, EPS and controls engineers, cable pullers, and electricians, to expedite progress on all areas of the work. Cable pulling in the satellite building began shortly after the cable study was completed. The progress is shown in the top two photos of Figure 6.

Cable termination and dressing of PDS components, shown in the bottom photo of Figure 6, also began this month. Regarding the utilities work in the satellite building, the electrical work is now complete and plumbing work for the high-capacity compressed air, which will deliver compressed air to the endstation air pads, and for the cooling water, is well underway.

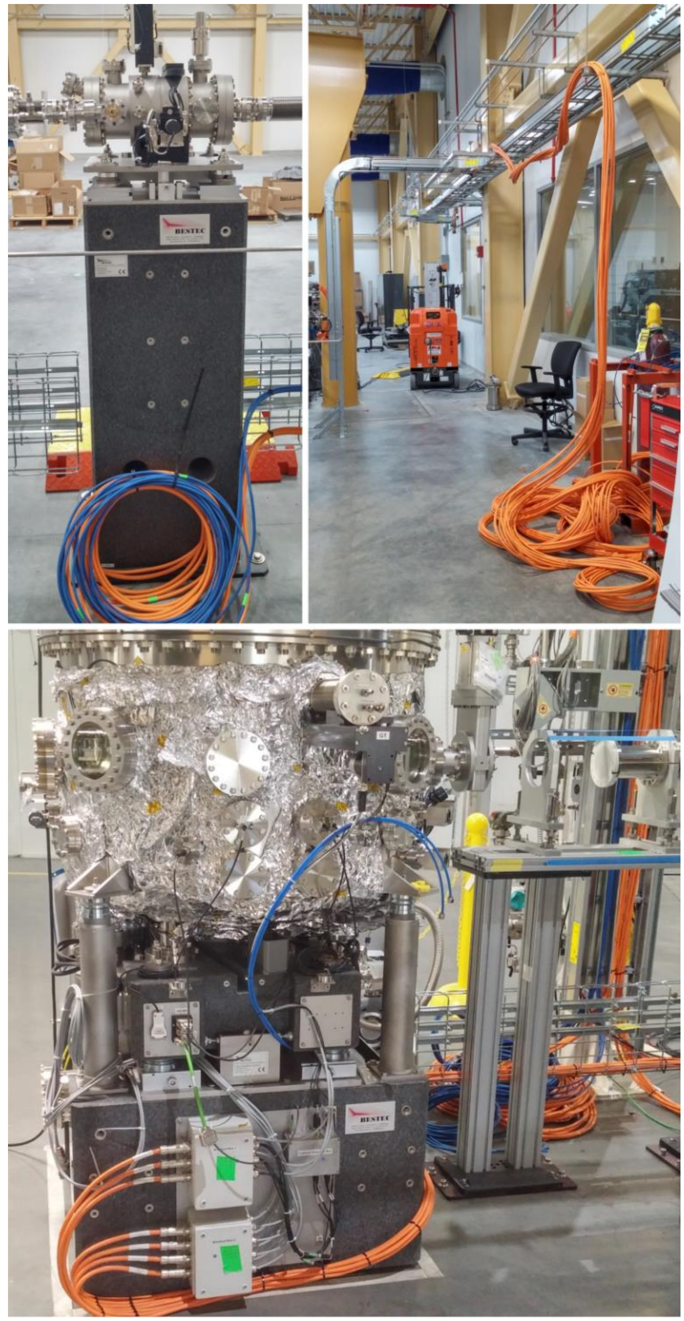


Figure 6: SIX: Motion cables being pulled along the cable tray of the SIX satellite building (top-right). Motion and signal cables pulled all the way to the exit slit (top-left). Motion cables for the PGM dressed and terminated (bottom).

The FAT of the SIX in-vacuum sample diffractometer was held at SmarAct on May 23-24. Most of the mechanical tests were very successful, showing repeatability under 200 nm, and crosstalk below 3 µm. Figure 7 shows the device during the FAT, with mirrors mounted at the sample holder location that were used for the interferometric measurements of motions and stability. Results of the vibrational tests, performed using a piezo shaker, are illustrated in the graph shown in Figure 8. Besides spikes at frequencies greater or equal than 150 Hz, the amplification factor mostly stays under 5, which is below the specified factor of 10.

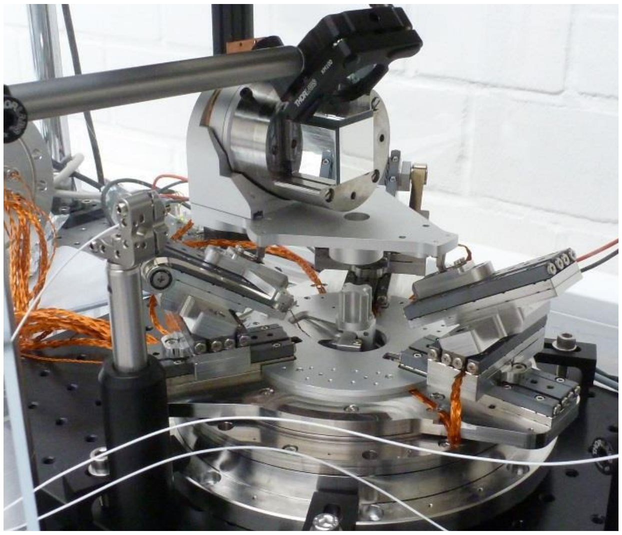


Figure 7: SIX: The SIX in-vacuum sample diffractometer undergoing mechanical tests during the FAT at SmarAct.

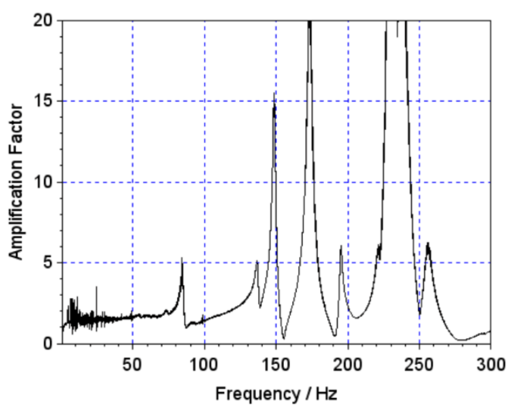


Figure 8: SIX: Vibration amplification ratio of the sample diffractometer as a function of frequency, measured by SmarAct during the FAT.

SMI – SOFT MATTER INTERFACES

From this month onwards, SMI activities will concentrate on managing fabrication and delivery of small value items while installing and testing the various components of the sample vacuum chamber assembly. This includes tasks such as: testing the powerful WAXS turbo pump, as soon as its supports are fabricated and installed; installing the 90 degree WAXS goniometer from Huber, as soon as pedestal supports are received from the shops; and installing and testing the Hexapod system, which was delivered at the end of May. Bench test of the Hexapod system uncovered discrepancies between the wiring diagrams and the equipment, such that the cables included with the equipment did not operate correctly. The team expects to uncover the remaining problems quickly and approve receipt of this equipment. In addition, the first DCM cold test, which was performed this month, uncovered damage to some cryo-cooler cables that had occurred after the cryo-cooler commissioning, as well as a dislodged DCM thermocouple at the first crystal that could not be detected with the equipment at room temperature. Fortunately, the cryo-cooler supplier was onsite for other business and able to make speedy repairs. The DCM thermocouple will be revised by the supplier for that component during a visit in August.

In service of being ready as early as possible for IRR, SMI accelerated effort to execute travelers and develop radiation safety documentation. SMI raytracing was nearly completed in May, with the exception of finalized layouts and the details of monochromatic beam excursions reflected from the FOE mirrors. SMI is scheduled to meet with the Radiation Safety Committee to review the preliminary raytracing on 21 June. Physicist Albert Hanson from BNL's EBNN Directorate has joined the NSLS-II team of specialists to provide Gas Bremsstrahlung (GB) and synchrotron shielding computations. Working with SMI, Al completed the FOE model for Fluka (primary and secondary GB analysis) at the end of May. The team expects feedback about the first calculation results in June. Figure 9 shows model components in the upstream part of the 12-ID-A hutch.

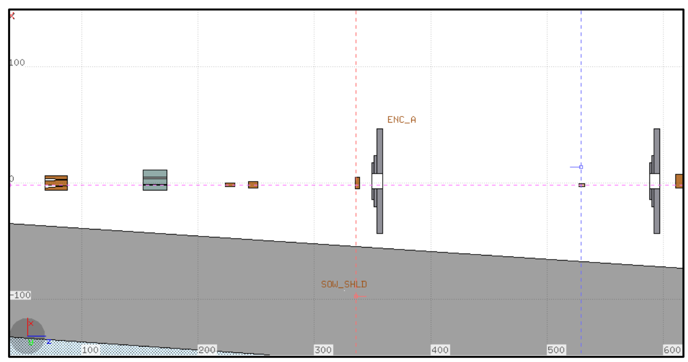


Figure 9: SMI: Top view of 12-ID-A beamline component model developed for SMI shielding calculations. The components shown are, from left: Dual Fixed Aperture Mask, Bremsstrahlung Collimator, White Beam Slits, Pinhole Mask, Pre-DCM Secondary Bremsstrahlung Shield, DCM Crystal, and Post-DCM Secondary Bremsstrahlung Shield. Part of the White Beam Stop is visible at right. Not shown: Bremsstrahlung Stop, Photon Shutter, and Guillotine with transport pipe penetrations.

No SAXS beamline is complete without a beamstop, and this item has been the final one in SMI's schedule to be designed. A multi-element beamstop has been design in complete detail and is currently in the Design Room en route to fabrication. Figure 10 shows the beam stop assembly that will ride on the Z-axis "trolley" that determines the distance from the Pilatus 1M detector to the sample. The detector is located in the left-foreground of this view, with the beam entering from the right-background through the rectangular aperture that frames the active area of the detector on its X-Y motion stages. There are three moving elements to the beam stop assembly. On a rail across the top of the support frame hangs a beam-blocking paddle on which a large photodiode will be mounted. This paddle, movable in X across the beam, is closest to the detector face, and protects the detector from the beam during long Z motions. On the lower rail, two independent X carriages carry respectively a spot-shaped beamstop, for transmission SAXS, and a stick-shaped element, to block intense specular scattering in the GISAXS geometry. These two stops incorporate vertical Y positioners to optimize beam stop position for each experiment. Photocurrent measurements are provided for the two lower stops. Not only does this arrangement provide robust protection for the detector, it enables rapid automatic alignment after a configuration change such as beam alignment, energy change, or detector Z translation. First, the paddle is inserted; its 10mm photodiode intercepts any foreseeable beam. Second, the stick beamstop can pass across the paddle. Both the shadow of the stick on the beamstop and the stick photocurrent provide feedback to center its position. This configuration can then be used with the paddle withdrawn, or the beam X position can be used to subsequently position the spot-shaped stop, enabling a small alignment scan to refine its Y position. Automated procedures such as this provide a labor-saving means of launching experiments quickly. Construction of the beamstop assembly, comprised of simple brackets and off the shelf parts, will be completed during the summer months.

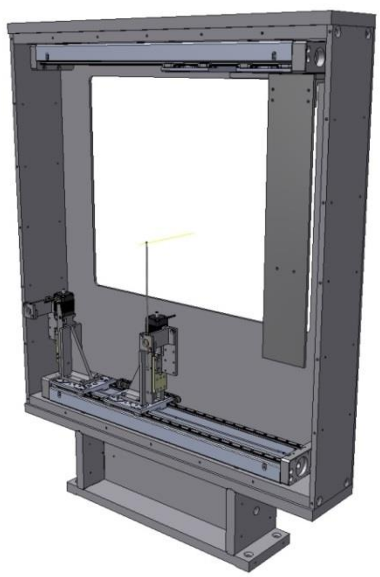


Figure 10: SMI: Model of the SMI in-vacuum beamstop assembly for the Pilatus 1M SAXS detector, as described in the text.

INSERTION DEVICES

The Final Mechanical Acceptance Test (FMAT) and the Final Control Acceptance Test (FCAT) for the ESM EPU105 were successfully completed at the Kyma site in Slovenia in mid-April. For these tests, the magnets were installed in random order on the mechanical frame to provide magnetic load. Since magnetic assembly and tuning were not included in this contract, Kyma unloaded the magnets from the mechanical frame and prepared the ESM EPU105 device for shipment by sea to BNL. The crated device is shown in Figure 11. The crates were transferred to Genova harbor on May 5 and the container left Italy on May 17. The container is expected to arrive in the US on May 30 and be delivered to BNL early in June.

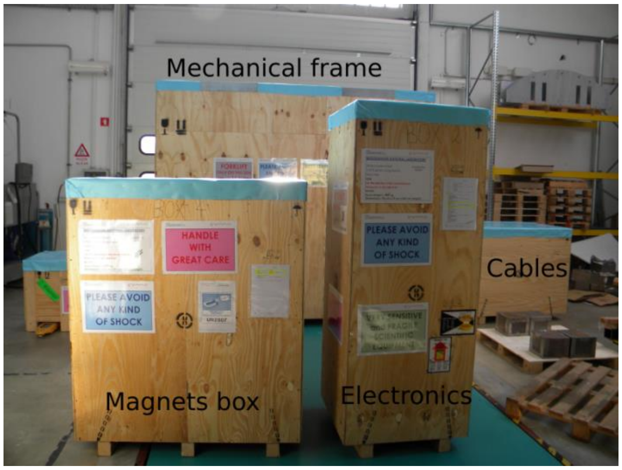


Figure 11: Insertion Devices: ESM EPU105 crated for shipment, to be installed in the downstream portion of cell 21.

Progress on the SIX EPU57 insertion device was made in May. This device was delivered by Kyma in March, with the magnets assembled on the EPU mechanical frame (this assembly was beyond contract terms with Kyma). This month, the SIX EPU57 device was transferred to the magnetic measurement laboratory in Building 832 and field measurements at minimum gap (both local field and field integral) were performed. Good agreement is observed between magnetic measurements made at BNL with those made at Kyma, as shown in Figure 12.

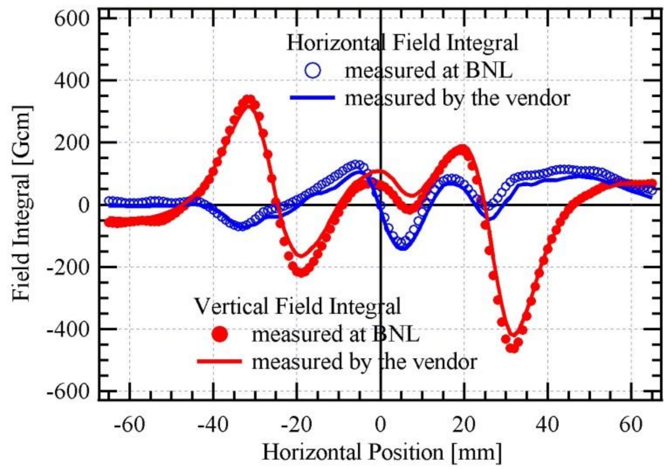


Figure 12: Insertion Devices: Comparison of the first field integral of the SIX EPU57 measured at Kyma (solid lines) and at BNL (open circles), at 16mm gap and phase 0.

During the next two months, the ID group will perform magnetic tuning of the SIX EPU57 device. Tuning of the undulator field is achieved by:

- Displacing magnets, horizontally and/or vertically. This type of correction is called virtual shimming.
- Inserting small magnets, also named magic fingers, near the ends of the device.

The long EPUs (SIX EPU57 and ESM EPU105) are designed to accommodate these two types of correction, as shown in Figure 13. The software IDBuilder, a multi-objective genetic algorithm, will be used to determine the virtual shimming (location and amount of displacement) and the distribution of magic fingers to be applied.

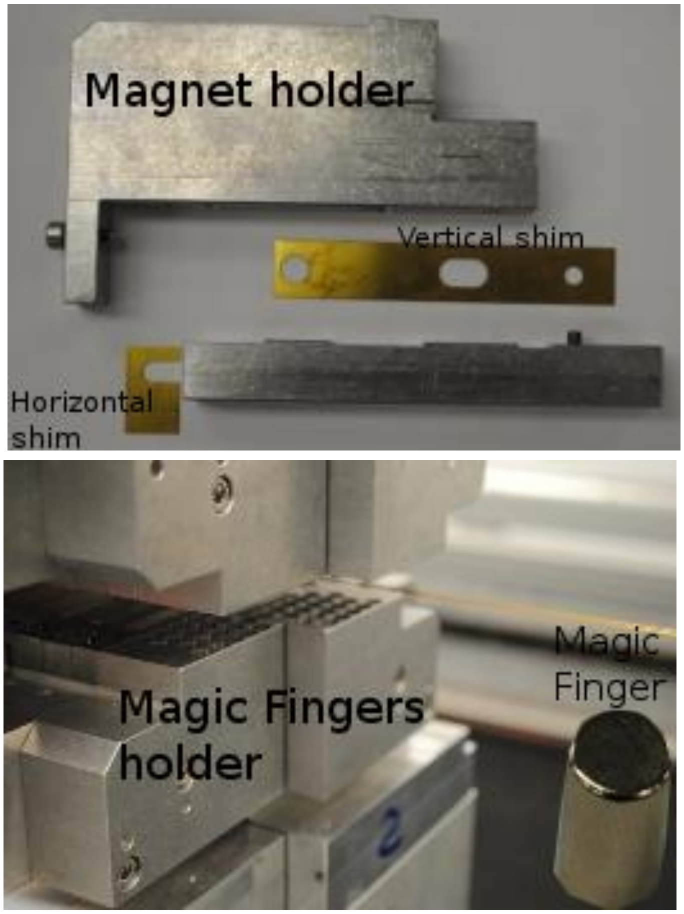


Figure 13: Provisions in the SIX EPU57 and ESM EPU105 design for virtual shimming (top) and magic finger correction (bottom).

PROJECT MILESTONES

Milestone	Planned	Actual
CD-0 (Mission Need):	May 27, 2010	May 27, 2010
CD-1 (Alternative Selection):	Sept. 30, 2011	Dec. 19, 2011
CD-2 (Performance Baseline):	Dec. 31, 2013	Oct. 9, 2013
CD-3A (Long Lead Procurement):	Dec. 31, 2013	Oct. 9, 2013
CD-3 (Start Construction):	Mar. 31, 2014	Jul. 7, 2014
Internal Early Project Completion – Beamlines	Jan. 13, 2017	
Early Project Completion:	Jan. 31, 2017	
CD-4 (Project Completion):	Sept. 29, 2017	

RECENT AND UPCOMING EVENTS

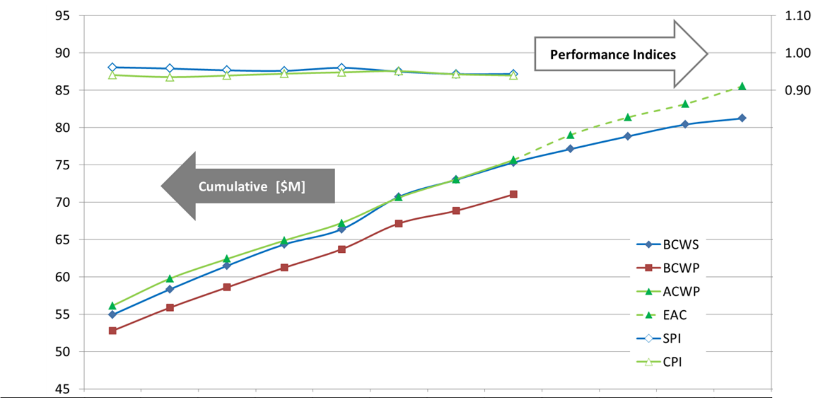
IRR for ESM and ISR	June 28-29, 2016
DOE OPA Status Review of NEXT	August 30-31, 2016
DOE OPA EVMS Review (BNL)	October 2016

Acronyms and Abbreviations

AC	Alternating Current
ACWP	Actual Cost of Work Performed
ARPES	Angle-Resolved PhotoElectron Spectroscopy
BAC	Budget at Completion
BCWP	Budgeted Cost of Work Performed
BCWS	Budgeted Cost of Work Scheduled
BDN	Beamlines Developed by NSLS-II
BNL	Brookhaven National Laboratory
BPM	Beam Position Monitor
BSA	Brookhaven Science Associates
CAM	Cost Account Manager
CD	Critical Decision
CPI	Cost Performance Index
CSS	Control System Studio
CV	Cost Variance
DCM	Double Crystal Monochromator
DI	De-Ionized
DOE	Department of Energy
DHRM	Double Harmonic Rejection Mirror
DPP	Dual Phase Plate
EAC	Estimate At Completion
EBNN	Environment, Biology, Nuclear Science & Nonproliferation
EPICS	Experimental Physics and Industrial Control System
EPS	Equipment Protection System
EPU	Elliptically Polarizing Undulator
ES&H	Environment, Safety & Health
ESM	Electron Spectro-Microscopy beamline
ETC	Estimated Cost to Complete
EVMS	Earned Value Management System
FAT	Factory Acceptance Test
FCAT	Final Control Acceptance Test
FDR	Final Design Review
FE	Front End
FEA	Finite Element Analysis
FMAT	Final Mechanical Acceptance Test
FOE	First Optics Enclosure
FPGA	Field-Programmable Gate Array
FTE	Full Time Equivalent
FXI	Full-field X-ray Imaging beamline
FY	Fiscal Year
GB	Gas Bremsstrahlung
GBS	Gas Bremsstrahlung Scatter
GHS	Gas Handling System
GISAXS	Grazing Incidence SAXS
HFM	Horizontal Focusing Mirror
ID	Insertion Device
IOC	Input / Output Controller
IRR	Instrument Readiness Review
ISR	Integrated In-Situ and Resonant X-ray Studies
ISS	Inner Shell Spectroscopy beamline
IVU	In-Vacuum Undulator
KB	Kirkpatrick Baez
M&S	Material & Supplies
NEXT	NSLS-II Experimental Tools project
NSLS	National Synchrotron Light Source
NSLS-II	National Synchrotron Light Source ll
OPA	Office of Project Assessment
OPC	Other Project Costs
PCR	Project Change Request
PDS	Photon Delivery System
PGM	Plane Grating Monochromator
PMB	Performance Management Baseline
PPS	Personnel Protection System
SAXS	Small Angle X-ray Scattering
SC	Office of Science
SIX	Soft Inelastic X-ray Scattering beamline
SMI	Soft Matter Interfaces beamline
SOE	Secondary Optics Enclosure
SPI	Schedule Performance Index
SSA	Secondary Source Aperture
SV	Schedule Variance
TEC	Total Estimated Cost
TPC	Total Project Cost
UB	Undistributed Budget
VAC	Variance At Completion
VBD	Visual Beam Diagnostic
VFM	Vertical Focusing Mirror
WAXS	Wide Angle X-ray Scattering
WBS	Work Breakdown Structure
WS	Working Schedule
XES	X-ray Emission Spectrometer

COST AND SCHEDULE STATUS

Cost and schedule progress is being tracked using an Earned Value Management System (EVMS) against the cost and schedule baseline established on October 1, 2013. All baseline changes are being controlled through the NEXT Change Control Board. Cost and schedule revisions are being managed using Project Change Control procedures. From June 2015 forward, EAC is reported as the sum of actual cost to date (ACWP) plus the estimated cost to complete (ETC), at the individual activity and resource level, with account-level cost corrections applied as needed to account for the difference between the Earned Value and accrual schedules. ETC values are shown in the final row of the EVMS table below, and all EAC changes are captured in the monthly EAC log.



Cum $M	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16
BCWS	54.9	58.3	61.5	64.3	66.4	70.7	73.0	75.3	77.1	78.8	80.4	81.2
BCWP	52.8	55.9	58.6	61.2	63.7	67.2	68.9	71.0				
ACWP	56.1	59.8	62.4	64.9	67.2	70.6	73.1	75.6				
SPI	0.96	0.96	0.95	0.95	0.96	0.95	0.94	0.94				
CPI	0.94	0.93	0.94	0.94	0.95	0.95	0.94	0.94				
ETC								11.9	8.5	6.1	4.4	2.0

NEXT as of 5/31/2016	Current Period	Cum-to-Date
Plan (BCWS) $k	2,305	75,308
Earned (BCWP) $k	2,187	71,041
Actual (ACWP) $k	2,585	75,643
SV $k	-118	-4,266
CV $k	-398	-4,602
SPI	0.95	0.94
CPI	0.85	0.94
Budget at Completion $k (PMB [UB])		82,611
Planned % Complete (BCWS/BAC)		91.2%
Earned % Complete (BCWP/BAC)		86.0%
Contingency $k		7,389
Contingency / (BAC – BCWP)		63.9%
EAC $k		87,498
Contingency / (EAC – BCWP)		44.9%
(Contingency + VAC) / (EAC – ACWP)		21.1%
TPC = PMB + Contingency		90,000

The NEXT project Schedule Variance (SV) for May 2016 is -$118k, with an associated monthly Schedule Performance Index (SPI) of 0.95 (green status). The largest contributors to the current month schedule variance are provided in the table below. The cumulative SPI is 0.94 (green status), the same as it was in April.

The NEXT project Cost Variance (CV) for May 2016 is -$398k, with an associated monthly Cost Performance Index (CPI) of 0.85 (yellow status). The primary contributors to the current month CV are provided in the table below. The cumulative CPI is 0.94 (green status), the same as it was in April.

Leading Current Month Variances [$k], May 2016

WBS	Title	PV	EV	AC	Schedule		Cost	
					SV	Issues	CV	Issues
2.01	Project Support	176	176	185	0	--	-9	--
2.03	Common Systems	283	208	234	-75	Utilities (2.03.01): +$84k (smoke detection programming work being completed later than scheduled); PPS (2.03.02): -$82k (delays as PEMP notable & partner beamlines have taken priority); EPS (2.03.03), -$18k; Control Station (2.03.04): (-$59k) late design and procurement	-26	Evenly spread among the four Level 3 WBS elements (average -$6k each)
2.04	Controls	114	117	113	3	--	4	--
2.05	ESM Beamline	141	133	258	-8	--	-125	CV dominated by accrual/payment on two contracts, the value for which was earned earlier: (i) installation of the M3 mirror in the ESM M1/M3 contract (-$83k), (ii) commissioning of the KB mirror system (-$30k)
2.07	ISR Beamline	201	442	440	241	(i) Installation and commissioning of the FOE Optics Package (+$274k), scheduled earlier, and (ii) slower progress on integrated testing than was planned (-$23k)	2	--

Leading Current Month Variances [$k], May 2016								
WBS	Title	PV	EV	AC	Schedule		Cost	
					SV	Issues	CV	Issues
2.08	ISS Beamline	291	266	410	-25	Positive EV for sample chamber receipt and installation activities earned in May, offset by negative EV for sample handling system, focusing mirror, and spectrometer mechanics activities	-144	(i) Pizza box (FPGA) costs incurred during May for work earned in prior months (March/April), (ii) under-reported EV for assembly, install, and test activities
2.09	SIX Beamline	172	250	353	77	Sum of activities scheduled in May but not performed yet [spectrometer test activities (-$38k)] and activities performed in May but scheduled earlier [assembly and test of M1M2 (+$4k), PGM commissioning report approval (+$17k), progress on sample manipulator fabrication (+$7k), and completion of various non-optics components fabrication (+$83k)]	-103	Accruals during May for activities earned earlier on the spectrometer (-$102k) and sample chamber contracts (-$16k)
2.10	SMI Beamline	375	366	332	-9	--	34	Favorable costs experienced for small value (non-APP) materials
2.11	Insertion Devices	551	229	260	-321	Sum of SV for: acceptance of SIX EPU57, scheduled earlier (+$56k), late acceptance of ESM EPU105 (-$115k), late SIX EPU57 shimming activities (-$81k), training at BNL, half of which was performed early and half late (-$188k), and net schedule variance on current strip power supply activities (+$13k)	-31	Labor cost overage during initial shimming work for SIX EPU
	Total	2305	2187	2585	**-118**	**Total**	**-398**	

As of May 31, 2016, the project is 86.0% complete with 63.9% contingency ($7.4M) for $11.6M Budget At Completion (BAC) work remaining, based on PCRs processed and approved through May 2016. The project EAC for May is reported at $87,498k against a Performance Measurement Baseline (PMB)/Undistributed Budget (UB) of $82,611k. The Variance At Completion (VAC) is given by VAC = BAC – EAC, with EAC = ACWP + ETC. Through May 2016, the VAC (-$4,887k) is dominated by the cumulative cost variance (-$4,602k), which is in turn dominated by labor cost overage on work performed to date.

The May 2016 EAC ($87.50M) is $0.84M higher than the April value. The increase is broken down as: $0.15M increase in BAC from PCRs; $0.40M cost overage on work performed ($0.14M M&S overage, $0.26M labor overage); $0.24M increase determined via the bottom-up EAC assessment (M&S -$8k, labor $245k; largest WBS Level 2 contributors: WBS 2.05 (ESM Beamline), for material and machining for white & pink masks and labor for IRR and endstation finishing, WBS 2.09 (SIX Beamline), for endstation installation support and grating metrology labor, offset by shifting spare grating procurements to operations, and WBS 2.11 (Insertion Devices), for materials for current strip power supplies and additional labor estimated to complete EPU shimming); and corrections ($0.05M).

As of the end of May, contingency on EAC is $2.50M, which represents 21.1% of $11.86M EAC work remaining. Outstanding commitments on fixed-price equipment contracts total $6.6M, so the $2.50M contingency on EAC represents 47.2% of $5.3M unobligated EAC work to go. ETC will continue to be assessed monthly through project completion to contain costs while maintaining the good schedule performance that the project has demonstrated to date.

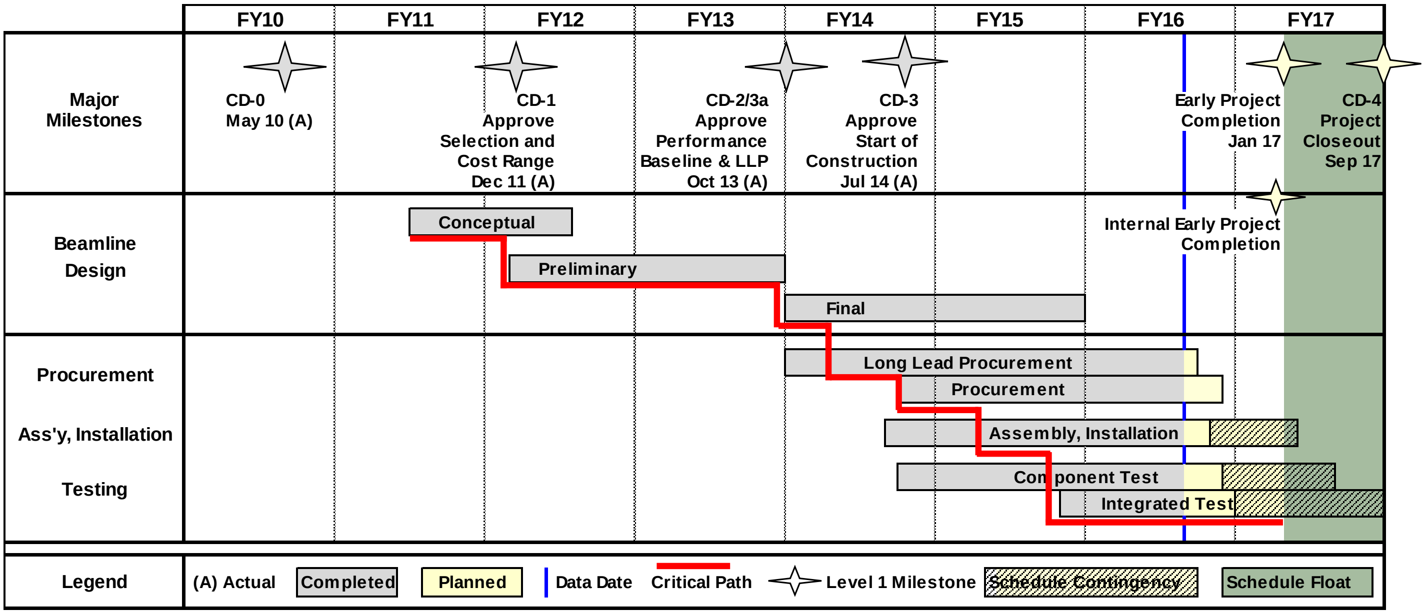
Two PCRs were approved and implemented in May.

PCR	PCR Level	Baseline Change [$]	Description
PCR-16-116	L3	153,790	APP 111NX Contract Award: additional SIX grating substrates
PCR-16-117	L3	0	ISR 6-Circle Diffractometer Contract Amendment

One PCR is planned for May: PCR_16_118, a Level 3 PCR in WBS 2.[05,09].01 (ESM, SIX Management) and WBS 2.[05,09].02 (ESM, SIX Beamline Systems) for contract awards and amendments, removal of the contract for SIX grating blanks (cost assumed by NSLS-II operations), along with additional small procurements and adjustments.

Milestones – Near Term		Planned	Actual
L3	SIX - Testing Monochromator and Slits complete	1-Mar-16	Expect July
L3	ISR - Installation of DCM Monochromator complete	15-Mar-16	Expect June
L3	Common Beamline Systems: Electrical Utilities Installed	29-Apr-16	27-May-16
L3	ESM - Testing Monochromator and Slits complete	12-May-16	27-May-16
L2	Complete Installation of 1st Beamline Components	25-May-16	30-Mar-16
L2, L3	Common Beamline Systems: Mechanical Utilities Installed	31-May-16	Expect August
L3	ISR – Installation of Beamline Components Complete	29-Jun-16	Expect June
L2	Receive EPUs for ESM and SIX	12-Aug-16	1-Jun-16
L3	Insertion Devices - ESM EPU105 Received	12-Aug-16	1-Jun-16
L3	SIX - Testing of Spectrometer Detector Complete	23-Aug-16	
L3	WBS 2.04 – Beamline Control Systems Complete	14-Sep-16	
L3	SMI – Installation of Beamline Components Complete	16-Sep-16	
L3	ESM – Installation of Beamline Components Complete	29-Sep-16	Expect June
L3	SIX – Installation of Beamline Components Complete	30-Sep-16	
L3	Common Beamline Systems: EPS Installed	30-Sep-16	
L2, L3	Complete Installation of Common Beamline Systems PPS	30-Sep-16	Expect December
L2	1st Beamline Available	30-Sep-16	13-Apr-16
L2	Early Project Completion – incl. IRR	31-Jan-17	

PROJECT SCHEDULE



As of May 2016, the critical path runs through PPS design, software development, testing, and integration for the SIX beamline (WBS 2.03.02, Common Systems PPS).

Staffing Report

Staffing as of 5/31/2016	Current Period		Cumulative-to-Date	
	Planned ** (FTE-yr)	Actual (FTE-yr)	Planned ** (FTE-yr)	Actual (FTE-yr)
WBS 2.01 Project Management and Support	0.75	0.60	36.53	33.47
WBS 2.02 Conceptual and Advanced Conceptual Design	0.00	0.00	8.74	8.74
WBS 2.03 Common Beamline Systems	0.79	0.88	26.62	14.49 *
WBS 2.04 Control System	1.30	0.67	19.38	17.88
WBS 2.05 ESM Beamline	0.54	0.66	14.99	16.55
WBS 2.06 FXI Beamline	0.00	0.00	4.77	4.60
WBS 2.07 ISR Beamline	0.90	0.56	15.12	13.67
WBS 2.08 ISS Beamline	0.29	0.43	13.96	14.01
WBS 2.09 SIX Beamline	0.67	0.61	17.19	20.03
WBS 2.10 SMI Beamline	0.26	0.45	14.02	13.50
WBS 2.11 Insertion Devices	0.19	0.32	4.95	4.89
WBS 2.12 ID & FE Installation	0.00	0.00	3.88	7.97
Total	**5.68**	**5.18**	**180.14**	**169.80**

** Based on the NEXT working schedule

* A large fraction of utilities installation has been performed by contractors (M&S) rather than staff as originally planned

Number of individuals who worked on NEXT during May 2016: 136

Funding Profile

Funding Type	NEXT Funding Profile ($M)						
	FY11	FY12	FY13	FY14	FY15	FY16	Total
OPC	3.0						3.0
TEC – Design		3.0	2.0				5.0
TEC – Fabrication		9.0	10.0	25.0	22.5	15.5	82.0
Total Project Cost	**3.0**	**12.0**	**12.0**	**25.0**	**22.5**	**15.5**	**90.0**

Key NEXT Personnel

Title	Name	Email	Phone
Federal Project Director	Robert Caradonna	rcaradonna@bnl.gov	631-344-2945
NEXT Project Manager	Steve Hulbert	hulbert@bnl.gov	631-344-7570

COST PERFORMANCE REPORT

	CONTRACT PERFORMANCE REPORT FORMAT 1 - WORK BREAKDOWN STRUCTURE	$	FORM APPROVED OMB No. 0704-0188
1. CONTRACTOR	2. CONTRACT	3. PROGRAM	4. REPORT PERIOD
a. NAME Brookhaven National Laboratory	a. NAME NEXT	a. NAME May 2016 NEXT Data	a. FROM *(YYYYMMDD)* 2016 / 05 / 01
b. LOCATION (Address and ZIP Code)	b. NUMBER	b. PHASE	b. TO *(YYYYMMDD)* 2016 / 05 / 31
	c. TYPE / d. SHARE RATIO	c. EVMS ACCEPTANCE X YES	

WBS (2) / WBS (3) ITEM (1)	CURRENT PERIOD BUDGETED COST WORK SCHEDULED (2)	WORK PERFORMED (3)	ACTUAL COST WORK PERFORMED (4)	VARIANCE SCHEDULE (5)	COST (6)	CUMULATIVE TO DATE BUDGETED COST WORK SCHEDULED (7)	WORK PERFORMED (8)	ACTUAL COST WORK PERFORMED (9)	VARIANCE SCHEDULE (10)	COST (11)	AT COMPLETION BUDGETED (14)	ESTIMATED (15)	VARIANCE (16)
2.01 Project Management and Support	176,369	176,369	184,889	0	(8,520)	8,554,933	8,554,933	9,347,463	0	(792,530)	9,918,232	10,677,685	(759,453)
2.01.01 Project Management	75,453	75,453	67,650	0	7,803	4,007,261	4,007,261	3,738,557	0	268,704	4,598,029	4,393,383	204,646
2.01.02 Project Support	100,916	100,916	117,238	0	(16,323)	4,547,672	4,547,672	5,608,906	0	(1,061,234)	5,320,204	6,284,303	(964,099)
2.02 Conceptual Design and Advanced Conceptual Design	0	0	0	0	0	1,807,316	1,807,316	1,807,316	0	0	1,807,316	1,807,316	0
2.03 Common Beamline Systems	283,216	208,169	233,693	(75,047)	(25,524)	6,566,697	6,201,067	7,606,170	(365,630)	(1,405,104)	7,266,877	8,782,927	(1,516,050)
2.03.01 Utilities	12,241	96,251	104,942	84,010	(8,691)	4,209,423	4,017,112	4,258,497	(192,311)	(241,385)	4,209,423	4,543,248	(333,825)
2.03.02 Personnel Protection System (PPS)	157,003	75,392	80,325	(81,610)	(4,933)	1,132,524	999,869	1,846,880	(132,655)	(847,011)	1,547,893	2,385,815	(837,922)
2.03.03 Equipment Protection System (EPS)	38,167	19,640	23,902	(18,526)	(4,262)	488,415	519,202	797,956	30,787	(278,754)	680,294	987,027	(306,733)
2.03.04 Control Station	67,511	8,591	14,219	(58,920)	(5,628)	279,588	208,137	149,022	(71,451)	59,115	306,744	247,768	58,976
2.03.05 Common Beamline Systems Management	8,294	8,294	10,304	0	(2,010)	456,748	456,748	553,815	0	(97,068)	522,524	619,070	(96,546)
2.04 Control System	113,971	116,561	112,689	2,589	3,872	4,228,045	4,238,255	4,404,699	10,210	(166,444)	4,558,236	4,785,533	(227,297)
2.04.01 Control System Management	5,200	5,200	4,707	0	493	263,369	263,369	238,952	0	24,417	294,427	270,023	24,404
2.04.02 Control System Design & Implementation	108,771	102,854	106,541	(5,917)	(3,688)	2,614,454	2,624,664	2,878,731	10,210	(254,067)	2,913,586	3,153,613	(240,028)
2.04.03 Control System Equipment	0	8,507	1,441	8,507	7,066	1,350,223	1,350,223	1,287,017	0	63,207	1,350,223	1,361,897	(11,673)
2.05 ESM Beamline	141,031	133,420	258,460	(7,611)	(125,040)	9,249,502	8,866,058	9,484,864	(383,444)	(618,806)	9,362,135	10,014,921	(652,785)
2.05.01 ESM Management	14,244	14,244	7,023	0	7,221	537,526	537,526	459,930	0	77,595	626,650	562,958	63,692
2.05.02 ESM Beamline Systems	126,787	119,176	251,437	(7,611)	(132,260)	8,711,976	8,328,532	9,024,933	(383,444)	(696,401)	8,735,485	9,451,963	(716,477)
2.06 FXI Beamline	0	0	0	0	0	1,818,324	1,818,324	1,793,425	0	24,899	1,818,324	1,793,425	24,899
2.06.01 FXI Management	0	0	0	0	0	409,359	409,359	470,908	0	(61,549)	409,359	470,908	(61,549)
2.06.02 FXI Beamline Systems	0	0	0	0	0	1,408,965	1,408,965	1,322,516	0	86,448	1,408,965	1,322,516	86,448
2.07 ISR Beamline	200,551	441,982	440,027	241,430	1,954	9,360,242	8,131,659	8,329,593	(1,228,584)	(197,934)	10,361,410	10,588,082	(226,672)
2.07.01 ISR Management	29,521	29,521	31,064	0	(1,543)	951,877	951,877	944,595	0	7,281	1,105,394	1,056,710	48,684
2.07.02 ISR Beamline Systems	171,030	412,461	408,964	241,430	3,497	8,408,366	7,179,782	7,384,998	(1,228,584)	(205,216)	9,256,015	9,531,372	(275,356)
2.08 ISS Beamline	291,114	265,953	410,391	(25,160)	(144,438)	9,932,328	9,694,657	10,453,981	(237,671)	(759,324)	10,472,212	11,132,745	(660,533)
2.08.01 ISS Management	13,543	13,543	18,119	0	(4,576)	648,236	775,644	631,956	127,408	143,688	838,199	650,141	188,057
2.08.02 ISS Beamline Systems	277,570	252,410	392,272	(25,160)	(139,862)	9,284,092	8,919,014	9,822,026	(365,079)	(903,012)	9,634,013	10,482,604	(848,591)
2.09 SIX Beamline	172,460	249,619	352,814	77,159	(103,195)	9,405,012	8,196,897	8,838,024	(1,208,115)	(641,127)	11,751,467	12,605,777	(854,309)
2.09.01 SIX Management	19,091	19,091	8,775	0	10,316	633,397	633,397	626,600	0	6,796	729,841	723,093	6,748
2.09.02 SIX Beamline Systems	153,369	230,528	344,040	77,159	(113,512)	8,771,615	7,563,501	8,211,424	(1,208,115)	(647,923)	11,021,626	11,882,684	(861,058)
2.10 SMI Beamline	375,353	365,931	332,374	(9,422)	33,557	8,606,433	8,058,622	8,276,840	(547,811)	(218,218)	9,108,910	9,171,400	(62,490)
2.10.01 SMI Management	11,789	11,789	11,069	0	720	682,830	682,830	610,658	0	72,172	802,179	733,645	68,535
2.10.02 SMI Beamline Systems	363,564	354,142	321,305	(9,422)	32,837	7,923,604	7,375,792	7,666,182	(547,811)	(290,389)	8,306,731	8,437,755	(131,024)
2.11 Insertion Devices	550,756	229,289	259,828	(321,467)	(30,538)	4,326,092	4,020,638	3,847,484	(305,454)	173,154	4,733,509	4,685,719	47,790
2.11.01 ESM EPU Insertion Device	548,056	226,589	257,468	(321,467)	(30,879)	4,127,677	3,822,224	3,699,633	(305,454)	122,590	4,515,912	4,518,679	(2,767)
2.11.02 SIX EPU Insertion Device	0	0	0	0	0	117,137	117,137	70,375	0	46,762	117,137	70,375	46,762
2.11.03 Insertion Devices Management	2,700	2,700	2,359	0	341	81,278	81,278	77,476	0	3,801	100,460	96,666	3,794
2.12 ID & FE Installation & Testing	0	0	0	0	0	1,452,816	1,452,816	1,452,960	0	(143)	1,452,816	1,452,960	(143)
2.12.01 ID & FE Installation & Testing Management	0	0	0	0	0	20,739	20,739	20,739	0	0	20,739	20,739	0
2.12.02 ID Installation & Testing	0	0	0	0	0	584,560	584,560	584,560	0	(0)	584,560	584,560	(0)
2.12.03 FE Installation & Testing	0	0	0	0	0	847,517	847,517	847,660	0	(143)	847,517	847,660	(143)
Total Project Baseline	2,304,820	2,187,292	2,585,164	(117,527)	(397,872)	75,307,742	71,041,243	75,642,819	(4,266,498)	(4,601,576)	82,611,446	87,498,490	(4,887,044)
Management Reserve													
Undistributed Budget													
Performance Management Baseline - PMB	2,304,820	2,187,292	2,585,164	(117,527)	(397,872)	75,307,742	71,041,243	75,642,819	(4,266,498)	(4,601,576)	82,611,446	87,498,490	(4,887,044)